Perception of safety and its association with physical activity in adolescents

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Introduction: Low levels of physical activity are associated with several non-communicable diseases. In Mexico 39.5% of adolescents do not meet the physical activity guidelines from the World Health Organisation. Previous literature suggests an association between perception of safety and physical activity. The aim of this paper is to examine the association between perceived crime and pedestrian safety and physical activity in Mexican adolescents.

Methods: Cross-sectional study with data from 4,079 adolescents between 15 and 18 years old in Mexico. Physical activity was measured with the Youth Physical Activity Questionnaire and was grouped into five domains: 1) moderate-to-vigorous physical activity, 2) sport activity, 3) leisure time activity, 4) Physical Education class, and 5) active commuting to school. Perception of safety was measured as pedestrian safety and crime safety, using the Neighbourhood Environment Walkability Scale-youth (NEWS-Y). A Confirmatory Factor Analysis was performed to examine the construct validity of NEWS-Y on the Mexican population. Data was collected in 2017 and analysed in 2018. Associations between physical activity and perception of safety were examined using linear regression models.

Results: Low perception of pedestrian safety was associated with lower moderate-to-vigorous physical activity per week (coef=-0.12, 95% CI=-0.19 to -0.05) and lower sport activity per week (coef=-0.13, 95% CI=-0.23 to -0.03) in females. There was no association between perception of safety and physical activity among males.

Conclusions: Pedestrian safety was negatively associated with moderate-to-vigorous physical activity and sport participation in females. Environments with better lighting, crosswalks and walking/cycle trails could increase females' physical activity.

BACKGROUND

Low levels of physical activity are associated with several non-communicable diseases (NCDs). In Mexico, 9.4% of adults have been diagnosed with diabetes, 25.5% with hypertension[1] and approximately 16% of premature deaths of people between 30 and 70 years old is attributed to NCDs.[2] The latest National Health and Nutrition Survey in Mexico (2016) reported that 39.5% of adolescents (48.8% females, 30.1% males) do not meet the World Health Organisation's (WHO) physical activity guidelines (60 minutes per day of moderate-to-vigorous physical activity).[1]

Mexico is a middle-income country which has experienced a fast pace of recent urbanisation. Currently, 63% of the population lives in urban areas and this is expected to reach 79% by 2050.[3] This rapid urbanisation poses a number of challenges in facilitating active lifestyles, such as creating recreational public spaces, incorporating cycling trails, and guaranteeing safety.[3,4] In Mexico, the second most common barrier to performing physical activity is lack of safe spaces (37.7%),[1] and the perception of safety has worsened in the last few years.[5] In the National Survey of Victimization and Public Security Perception (2018),[6] 79.4% of Mexicans reported that they perceive their city as unsafe to live in and 33.4% have stopped going out for walks as a result. Regarding pedestrian safety, 62.6% Mexicans identified insufficient public lighting as an issue, 49.6% perceived streets in their city to be frequently full with traffic and 38% mentioned neglected parks and public spaces.[5] Consequently, 68.6% of adults would not let their children (<18 years) go out alone,[7] possibly constraining their physical activity to indoor areas or spaces considered as "safe". There is a risk that rapid and unplanned urbanization in Mexico will affect crime and pedestrian safety, and therefore may reduce physical activity.

Previous literature has explored the associations between perception of safety and physical activity. A recent meta-analysis including studies from low-and middle-income countries found that people reporting feeling safe from crime had 27% greater odds of achieving higher levels of physical activity, compared to those living in areas with higher crime rates.[8] However, another systematic review reported that only 10.1% of the papers included found a negative association between physical activity and crime safety.[9] This surprising finding could be because studies were conducted in high-income countries where crime rates are significantly lower than in low-and-middle income countries. Similarly, pedestrian safety, the presence of traffic lights and walking tracks have been associated with greater active travel among female adolescents[10] and low neighbourhood safety has been found to decrease the odds of being physically active outside school by 48%.[11] Although these studies indicate how the perception of safety is associated with physical activity, information is needed about this relationship in middle-income countries where a high rate of crime is experienced along with rapid urbanisation. Also, as most data pertaining to perceptions of safety in Mexico is amongst adults, there is a need to better understand how young people's perceptions of safety are associated with their physical activity. Moreover, physical activity research in Mexico, especially in adolescents, is not as advanced as in other Latin American countries (e.g., Brazil, Colombia).

The aim of this study was to examine the association between perceived crime safety (fear of being hurt by a stranger), perceived pedestrian safety (how safe does walking feel in terms of traffic) and five domains of physical activity (moderate-to-vigorous physical activity, sport

participation, leisure physical activity, Physical Education class, and Active Commuting) in a sample of Mexican adolescents between 15 and 18 years old.

METHODS

STUDY DESIGN AND SETTING

The study used a cross-sectional design conducted in Mexico City and Oaxaca. These two states were chosen due to their difference in criminal activity (Mexico City=49,913 per 100,000 habitants vs. Oaxaca=27,897) and urbanisation level (Mexico City=58.16 vs. Oaxaca=39.70, on a zero to 70 scale comprising the subscales: population density, economic activity, built environment, communication, education, diversity and health).[4,12] Data were collected between February and June 2017. Adolescent physical activity and perception of safety were self-reported. Ethical approval was obtained by [INSTITUTION DETAILS HAVE BEEN REMOVED FOR PEER-REVIEW].

RECRUITMENT OF SCHOOLS & PARTICIPANTS

A list of private and public schools of Mexico City and Oaxaca was obtained from the Department of Education in Mexico. Municipalities from both states were stratified by level of urbanicity (low, medium, high) according to previous research,[4,12] and SES tertile (low, medium, high) according to the Life Quality Index from the National Electoral Institute in Mexico.[13] Eighty schools of each stratum per state were randomly selected (n=1,440), from which 1,319 were eligible (students' age=15-18), 517 were excluded for being in areas considered as unsafe for the researcher,[14] and 706 for having private contact details, leaving a

total of 96 eligible schools. These schools were contacted via phone number, 79 did not reply and seven refused to take part in the study, resulting in 10 schools (Mexico City: n=6, Oaxaca: n=4) which agreed to participate.

In each school, all students between 15 and 18 years old and present at the day of data collection were included (females=2074, males=2005). A more detailed description of the recruitment process and the percentage of students belonging to each school is available in Appendix 1. Data was collected using printed questionnaires applied by the lead researcher during school hours. Students completed the 45 minute questionnaire after reading an information sheet and completing a consent form.

ASSESSMENT OF PHYSICAL ACTIVITY

The duration and frequency of physical activity in the last 7-days was measured with the Youth Physical Activity Questionnaire (Y-PAQ). The Y-PAQ covers a range of activities performed during school time, leisure time, weekdays and weekends giving a comprehensive measure of adolescents' physical activity,[15] and has demonstrated test-retest reliability (ICC=0.79, $p<0.001$) and construct validity ($r=0.46$, $p=0.03$)[16] amongst adolescents. Due to the Y-PAQ not being available in Spanish, it was back-translated from English (Appendix 2). The list of activities were grouped into five domains: 1) Moderate-to-vigorous physical activity (any activity with a metabolic equivalent≥4 METS)[17], 2) sports activities (e.g., football, gymnastics, swimming), 3) leisure time activities (e.g., bowling, roller-skating, playing with pets), 4) Physical Education (PE) class at school, and 5) active commuting to school (walking, cycling). The five domains of

physical activity were calculated as continuous variables by multiplying duration (minutes) by frequency (times per week) of the activities listed in the YPAQ questionnaire.[18]

ASSESSMENT OF PEDESTRIAN SAFETY AND CRIME SAFETY

Perceptions of safety were assessed using the "Pedestrian Safety" and "Crime Safety" sub-scales from the Neighbourhood Environment Walkability Scale-youth (NEWS-Y).[19] This tool was translated for the purpose of this research from English to Spanish in order to be used in the Mexican population. The NEWS-Y is an empirically-derived measure of various aspects of the built environment related to walking in adolescents[20], from which pedestrian and automobile traffic safety and crime safety subscales had acceptable test-retest reliability (ICC=0.67 and ICC=0.73 respectively) in a previous study with adolescents (12-18 years old).[21] The pedestrian safety sub-scale comprises six questions related to how safe participants feel walking around the neighbourhood in terms of traffic safety (e.g., drivers go faster than the posted speed limits), while the crime safety sub-scale comprises five questions related to their level of fear of being hurt by someone in their neighbourhood (e.g., I am afraid of being taken/hurt by a stranger in a local park). Items from both subscales are measured with a one to four scale (i.e., strongly disagree, somewhat disagree, somewhat agree, strongly agree). Subscale scores were calculated as the mean of the subscale items with higher scores indicating a lower perception of pedestrian safety and crime safety.

STATISTICAL ANALYSIS

The five outcomes of physical activity were assessed for normality through Shapiro-Francia test and skewness and kurtosis. Due to non-normality, physical activity data were log-transformed. The continuous variables of pedestrian safety and crime safety had a normal distribution.

There is no existing evidence for the construct validity of the crime and pedestrian safety subscales of the NEWS-Y in Mexican adolescents. As such, a Confirmatory Factor Analysis (CFA) was performed to examine the construct validity of the hypothesized structure and relation between the subscales. The full methods and results of this analysis are in Appendix 3. The final model comprised of three items assessing pedestrian safety (α=0.583) and five items assessing crime safety (α=0.794). Even though item 2 (Speed of traffic on most streets is usually slow) did not load on either factor, it was retained and analysed as a separate item to minimise the loss of information.

To increase statistical power, multiple imputation by chained equations of missing data was implemented for 4,079 participants. Seventy eight percent of participants provided complete data, for all other participants values were missing at random and data was imputed to create a complete data set. The physical activity outcomes, the safety items resulting from the CFA and participants' characteristics that were potential predictors of missingness (i.e., gender, weight, height, age, school and state) were included in the imputation model. Twenty imputed datasets were created using 20 cycles of regression switching and results were then averaged over these datasets using Rubin's rules.[22] Complete case analysis of the original dataset is available in Appendix 4, showing minimal/no differences with the analysis using the imputed dataset.

Descriptive statistics were calculated for variables in the imputed data, Body Mass Index (BMI) was computed by using the BMI Index Cut-Offs for children (five to 19 years old) from the WHO.[23] The associations between the three perception of safety variables (i.e., high speed of traffic, pedestrian safety, crime safety) and the five physical activity outcomes were examined using linear regression models. During exploratory analysis, the Wald test showed that by including gender in the models, the fit would be improved ($p<0.05$), therefore, separate models for females and males are presented. Five linear regression models were run with physical activity outcome variables (MVPA, sport activity, leisure activities, PE class, active commuting) and exposures of perception of safety (i.e., high speed of traffic, pedestrian safety, crime safety) for males and females separately. Due to the log transformation of physical activity variables, the linear regressions must be interpreted as: $\ln Y_i = \alpha + \beta x_i + \varepsilon$, where a unit increase in x_i results in an expected increase in $\ln Y_i$ of β. According to Benoit (2011), by performing a Taylor series expansion, $e^{\beta} \approx 1 + \beta$ for $\beta \ll 1$, and therefore the interpretation of $\exp(\beta)$ is as a percentage, meaning the expected percentage change in Y for a unit increase in x.[24]

All models were adjusted for parents' education level, participant age, BMI and state. Robust standard errors were used in all models to account for the clustering (non-independence) of children in schools. All analyses were performed in STATA (Version 13), College Station, TX.

RESULTS

The results of the CFA are shown in Table 1. Factor loadings for pedestrian safety showed a strong association to the underlying factor (ranged from 0.44-0.68) as well as factor loadings for crime safety (0.46-0.75). Pedestrian safety and crime safety showed mean values greater than 2 (1 being safe and 4 unsafe), being greater among females than males.

Descriptive statistics of participants' physical activity are shown in Table 2. In all the physical activity outcomes, except for leisure physical activity, males reported more minutes per week than females. The prevalence of overweight and obesity was higher among males (26.71% and 6.13%, respectively) compared to females (20.46% and 2.85%, respectively).

The adjusted associations between perceived safety and physical activity outcomes are shown in Table 3. In females, every unit increase of pedestrian safety (i.e., feeling less safe) was associated with 12% lower MVPA per week (Coef. -0.12, 95% CI=-0.19 to -0.05), and 13% less sport activity per week (Coef. -0.13, 95% CI=-0.23 to -0.03). Crime safety and high speed of traffic were not associated with physical activity participation in females. There were no associations between either crime, pedestrian safety nor high speed of traffic and any physical activity variables amongst males.

DISCUSSION

In this study, the perception of lower pedestrian safety was associated with lower MVPA and sport participation amongst females. Considering the mean MVPA of 671.61 minutes per week amongst the females in the sample, the observed association would imply a difference of 241.77

minutes per week (671.61 min per week of MVPA x 0.12 x 3 units of difference of pedestrian safety) of MVPA between a female perceiving high pedestrian safety (score 1 in the scale) and a female perceiving low pedestrian safety (score 4 in the scale). Similarly, a mean of 450.17 minutes per week of sport-related physical activity would imply a difference of 175.57 minutes per week of sport activity between a female perceiving high pedestrian safety and a female perceiving low pedestrian safety. Findings suggest that, this increment of MVPA and sport participation might be the difference between meeting and not meeting the WHO's physical activity guidelines for some Mexican females.

As in many studies in Mexico and in other countries,[25–27] females reported less physical activity than males, and the data reported here suggest that pedestrian safety might be a contributing factor for this. It is feasible that the lack of lighting in public spaces generates uneasiness and a feeling of being a target of crime among females. It has previously been shown that the presence of traffic lights is associated with greater active transport among female adolescents.[10] Evidence suggests that accessibility (i.e., how easy it is to get to…) to sport facilities (basketball courts, parks, swimming pools...) is positively associated with the MVPA of female adolescents,[28,29] further, the total length of walking trails has been associated with greater active transport among this population.[10] Another explanation why perception of low pedestrian safety affects females might be previous negative experiences in the neighbourhood and a sense of risk. As such, it may be the case that the lack of cycling/walking trails and crosswalks in areas with heavy traffic might be discouraging for females' MVPA and sport involvement.[11]

198 In this study there was no association between active commuting and the perception of safety.
199 This lack of an association could be because in Mexico adolescents have to walk or cycle to
200 school in spite of safety perceptions as their family does not own a private vehicle. Previous
201 research in adults has shown that physical activity in Mexico is strongly driven by necessity
202 (i.e., active commuting to work) rather than by leisure.[30] Even though this study did not measure
203 how many adolescents had a car in their family, it is known that in Mexico the percentage
204 family car ownership is low (23%)[1] and therefore 75% of trips to school are done through active
205 commuting.[31] It could be said that active transport in Mexico is a necessity and not choice, so
206 the influence of environmental factors might not be so relevant.

207

208 A positive association between increased safety and leisure physical activity was expected.
209 However, it is possible that part of adolescents' recreational activities are carried out within
210 school facilities and the YPAQ did not capture these activities. Moreover, participation in PE
211 class is usually performed inside school or on external school facilities in which cases transport
212 is provided.

213

214 In this study a Spanish version of the NEWS-Y scale was used to assess pedestrian safety and
215 Crime Safety. While testing the hypothesised factor structure, three items from the pedestrian
216 safety subscale, showed weak associations with other items of the same latent variable and also
217 cross-loaded with crime safety. Cross-loading could be explained by the order in which the
218 questions were asked (i.e., one item belonging to crime safety is placed in the middle of the

pedestrian safety items) and participants could have followed a pattern of answers without fully reading the individual items. Future research should test new arrangements of items.

STRENGTHS AND LIMITATIONS

This study is the first study in Mexico that studies the association between perception of safety and physical activity in the adolescent population, therefore it contributes to the dearth of evidence in this population in Latin America. Among the strengths of the study is the use of a large dataset with complete physical activity information for 4,079 adolescents. In addition, support for the validity of the NEWS-Y measures of pedestrian and crime safety among Mexican adolescents was provided. Another strength is the assessment of perceived safety opposed to an objective measure of safety. This is important because perceived measures acknowledge how people feel in their neighbourhood and surroundings and how these influence their behaviour, compared to objective measures (i.e., crime statistics) provided by the government.[32] The study is limited by the cross-sectional design that prevents drawing conclusions pertaining to the causality of the perception of the safety-physical activity relationship. Also, the use of self-reported measure to assess physical activity might be responsible for the high levels of physical activity (over-reporting). Schools were excluded if they were in a very unsafe area, which could mean not covering the "full range" of safety as the physical activity-perception of safety relationship was only observed at the higher end of the scale (highest safety). This might lead to an overestimation of the perceptions of safety and to not be generalizable to unsafe areas. Moreover, it is important to mention that the exclusion of schools in unsafe areas and schools without contact details may limit the extent to which the sample is representative of the adolescent population of Mexico City and Oaxaca. In the case of

the perception of safety measurement, although the NEWS-Y items were back-translated, no examination of the clarity of the questions in Spanish was piloted and these steps are needed to develop a more robust measure of perception of safety.

CONCLUSIONS

Perception of pedestrian safety was negatively associated with MVPA and sport participation in females, there was no association among males. Results from this study suggest that environments with better lighting, crosswalks, walking trails and signals on busy streets could increase females' MVPA and sport participation. Future research should examine the association between perception of safety and physical activity in a representative sample from all areas of the security spectrum, also physical activity should be measured objectively (i.e. accelerometer). Moreover, an examination of the clarity of the questions of the NEWS-Y in Spanish should be performed.

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